

PARTICULATE MATTER AMBIENT AIR QUALITY

DATA REPORT FOR 1991

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1.0 EXECUTIVE SUMMARY

Routine particulate matter ambient air quality monitoring has been performed at two stations in the Yucca Mountain air monitoring network since the spring of 1989. The monitoring was established to: (1) support air quality permit monitoring requirements, and (2) use in general environmental characterization of the Yucca Mountain area. The monitoring program is described in the "Scientific Investigation Implementation Package for Air Quality Monitoring" (SIIP, YMP document TMSS/EFPD-91-002), and is implemented through Technical and Management Support Services (T&MSS) Work Instruction procedures. This document is a report of monitoring results for 1991, with some comparisons to previous years. Data from 1989 and 1990 were presented in a previous report.

The air quality monitoring work is included in Work Breakdown Structure 1.2.13.4.2 (previously designated 1.2.5.4.2); T&MSS Environmental Field Programs Division is the responsible organization. The Quality Assurance Grading Report (No. T12542A) for this activity shows the work to be classified as not quality affecting.

The field sampling is performed using high-volume samplers for two size ranges of suspended (airborne) particulate matter: total suspended particulate matter (TSP) and the inhalable portion of suspended particulate matter, also known as PM_{10} or PM-10. The sampling period is 24 hours; samples are taken every sixth day following the Environmental Protection Agency national schedule.

The National and Nevada primary and secondary ambient air quality standards for particulate matter are based on PM_{10} sampling. Prior to 1987, the National Standards applied to TSP; the Nevada particulate matter standards were based on TSP until 1991. TSP sampling is being continued to determine the fraction of total suspended particulate matter that is in the inhalable size range (PM_{10}).

Monitoring results were not required to be reported to the State of Nevada until Nevada Air Quality Permit to Construct No. 2693 was granted on June 12, 1991. One permit condition requires reporting PM_{10} results on a quarterly basis. Reports on the PM_{10} monitoring are submitted quarterly by the Yucca Mountain Site Characterization Project Office to the State of Nevada, Department of Conservation and Natural Resources, Division of Environmental Protection, Bureau of Air Quality. The first report to the State covered the data sampled during July through September 1991.

The monitoring results from 1991 showed that the area remained in compliance with State of Nevada and Federal ambient air particulate matter standards. The standards are given in Table 1-1, with a summary of the monitoring results. The highest 24-hour concentrations observed were well below the value used to determine an exceedance, therefore the number of exceedances in each calendar year is zero. Further, the annual average concentrations were well below the standard. These results are very similar to those from the monitoring since it began in 1989.

The methods used in the ambient air quality particulate matter monitoring program are described in Section 2. The PM_{10} and TSP monitoring results are presented in Section 3. Regulatory quality assurance requirements and results are also presented in both sections.

TABLE 1-1. Summary of Particulate Matter Monitoring Results for 1991.

Data shown are 24-hour sampling results and quarterly arithmetic mean values, expressed in micrograms per standard cubic meter ($\mu\text{g}/\text{m}^3$). See note⁽¹⁾ for National Ambient Air Quality Standards (NAAQS).

PM_{10}	Data Recovery ⁽²⁾ (%)	24-hr ⁽³⁾ ($\mu\text{g}/\text{m}^3$)	Annual Average ($\mu\text{g}/\text{m}^3$)
NTS-60 (Main) Site			
Primary ⁽⁴⁾	98.3%	33	10
Collocated ⁽⁵⁾	98.3%	31	10
40-Mile Wash Site	88.3%	46	11
<u>TSP</u>			
NTS-60 (Main) Site			
Primary ⁽⁴⁾	80.0%	63	22
Collocated ⁽⁵⁾	83.3%	63	22
40-Mile Wash Site	86.7%	103	25

NOTES:

- (1) NAAQS: Title 40 Code of Federal Regulations (CFR) Part 50.6, maximum allowable PM_{10} concentrations used with 40 CFR 50 Appendix K to determine expected number of occurrences of sampling results exceeding the standard. The State of Nevada adopted the National standard (NAC 445.843) in 1991. The 24-hour and annual standards are basically:
 - the expected annual number of exceedances of 24-hour level (individual samples with concentrations in excess of $150 \mu\text{g}/\text{m}^3$) must be less than or equal to one, and
 - the annual arithmetic mean must be less than or equal to $50 \mu\text{g}/\text{m}^3$.
- (2) Data recovery is the number of valid samples, expressed as percent of possible; a minimum of 80% is required for the air quality permit.
- (3) Highest 24-hour result in the year.
- (4) Primary sampler is source of monitoring results.
- (5) Collocated sampler is operated to obtain quality assurance "precision" results.

2.0 PARTICULATE MATTER AMBIENT AIR QUALITY MONITORING METHODS

This section is a brief discussion of the methods used for ambient air quality monitoring for particulate matter in the Yucca Mountain network. Detail is presented in the SIIP for Air Quality Monitoring, and the T&MSS Work Instructions WI-AQ-001, "Routine Operations and Maintenance for Ambient Particulate Sampling", and WI-AQ-002, "Calibrations and Performance Audits of Particulate Matter Samplers".

The monitoring program is designed to meet U.S. Environmental Protection Agency (EPA), and State of Nevada, regulations and guidelines applicable to PM_{10} monitoring. The TSP monitoring program follows previous similar EPA regulations, which are no longer in effect. The nominal upper particle sizes sampled are approximately 50 micrometers for TSP, and an aerodynamic diameter of 10 micrometers for PM_{10} .

Particulate matter ambient air quality was monitored at two network site locations. The NTS-60 (Main) site is located in Midway Valley immediately east of the main Yucca Mountain Ridge. The 40-Mile Wash site is about half-way from Yucca Mountain to the Amargosa Valley area, in the valley floor that contains the Forty-Mile Wash. Both sites include PM_{10} and TSP monitoring.

2.1 Monitoring Requirements and Procedures

To meet EPA requirements, the PM_{10} equipment used must meet Reference Method designation requirements given in 40 CFR 53, Subpart D. Both types of samplers used in the network are manufactured by Wedding & Associates; the PM_{10} samplers are designated Reference Method RFPS-1087-062.

Further EPA requirements for the monitoring methods are specified in 40 CFR 50, Appendices B (TSP), and J (PM_{10}). T&MSS procedures covering ambient air quality for particulate matter are given in Work Instructions WI-AQ-001, "Routine Operations and Maintenance for Ambient Particulate Matter Sampling," and WI-AQ-002, "Calibrations and Performance Audits of Particulate Matter Samplers." T&MSS data processing procedures are given in WI-AQ-001.

Gravimetric analyses are performed on the filters to determine the net mass of particulate matter collected on the filter. This result is used, with sampler airflow information, to determine average concentration of suspended particulate matter.

2.2 Quality Assurance

EPA quality assurance requirements for Prevention of Significant Deterioration Monitoring Programs are given in 40 CFR 58, Appendix B. These were adopted by the State of Nevada for the air quality permit monitoring that began in 1991.

The quality assurance items addressed are:

- perform "precision" assessments using collocated samplers,
- achieve 80 percent "completeness," or data recovery.

The "collocated" samplers used in precision assessments are at the NTS-60 site; only one site in a network is required to have collocated samplers. Collocated samplers are identical samplers mounted near the primary samplers, and are operated on the same schedule and with the same procedures as the primary samplers. Comparisons of the results from the sampler pair are used in the "precision assessment."

Data recovery rates were calculated as the number of valid samples reported compared to the number possible during the monitoring period. Data from the collocated sampler are reported with the primary sampler results to optimize data reporting capability. On one occasion, the primary sample was invalid due to motor problems, and the collocated sample was reported in the table as a primary result. This result was not used in assessing precision.

9 1 1 0 3 0 1 5 3

3.0 RESULTS

Individual sampling results, quarterly and annual summaries, and relationships between results from 1991 and from previous years are presented in this section. The highest 24-hour concentrations observed were well below the Standard used to determine an exceedance; therefore, the number of exceedances in each calendar year is zero. Further, the annual average concentrations were well below the annual Standard.

3.1 Individual Sampling Results

Results of each sampling event are reported in Tables 3-1 through 3-4 in calendar quarter-year periods. Each table shows PM_{10} and TSP concentrations by sampler and by date; concentrations are reported in micrograms per standard cubic meter, in keeping with the units of the Standards. The samplers are identified by letter-number designations, which are explained in the footnotes of the tables. The tables also show the following summary statistics:

- Data recovery rates are provided in the "Reported" row of the tables.
- The quarterly average concentrations are reported in the "Average" row.
- The highest and second-highest sampling results for each period are presented in the "Highest" and "2nd-high" rows. The second-highest results are reported as indications if the highest result is an extreme outlier or not. Also, previous particulate matter standards were based on the second-highest 24-hour average; some reviewers still request these data.

The results show ambient particulate concentrations are consistently well below applicable standards, which are very good air quality conditions. The highest 24-hour PM_{10} and TSP concentrations were 46 and 103 micrograms per cubic meter ($\mu g/m^3$), respectively, for the annual period. The pattern of PM_{10} and TSP results were similar between the NTS-60 and 40-Mile Wash sites, that is, the dates of relatively higher concentrations occurring at one site typically coincided with the occurrences of higher concentrations at the other site. Also, similar annual trends were noted in the PM_{10} and TSP results.

The data recovery rates met or exceeded the 80 percent level typically used as a minimum for regulatory monitoring purposes, with the following exceptions:

- The April through June PM_{10} and TSP rates at the 40-Mile Wash site fell to 66.7 and 73.3 percent, respectively, partly due to extended electrical power outages experienced at the site during construction of a nearby well facility.
- The January through March TSP rate from the collocated sampler at the NTS-60 site fell to 66.7 percent, primarily due to problems encountered with the motor brushes.
- The October through December TSP rate from the primary sampler at the NTS 60 site fell to 73.3 percent, due to motor problems.

Corrective action has been taken on the motor problems that lead to the data losses described above. The data recovery rates in 1992 reflect an improvement in this area.

3.2 Quality Assurance Results

Typical regulatory requirements include reporting results of the assessment of the completeness and precision of the data. Completeness was discussed above in the reporting of data recovery results. Precision is expressed as the upper and lower "probability intervals", which correspond to the 95 percent confidence intervals. The intervals are calculated by the following steps.

- (1) The differences (d_i) between the primary (X) and collocated (Y) sampler results are calculated from:

$$d_i = (Y - X) / [(Y + X) / 2].$$

- (2) The mean (D) and standard deviation (s) of the differences (d_i) are calculated for the quarterly and annual periods. These are used in the following to calculate the upper (UL) and lower (LL) probability interval values:

$$UL = D + 1.96 \cdot s / (\sqrt{2}), \text{ and}$$

$$LL = D - 1.96 \cdot s / (\sqrt{2}).$$

A summary of the precision assessment results is reported in Table 3-5. There are no guideline measures of acceptability of precision results; interpretation is left to the user of a given data set. These results are viewed as acceptable, particularly given the very low concentrations used to calculate the comparative differences. Differences between two small concentration numbers can appear large when expressed in percent. For example, the percent difference for a primary result of $4 \mu\text{g}/\text{m}^3$ and a collocated result of $3 \mu\text{g}/\text{m}^3$ is -29%.

Given the possibly misleading percent-difference results that can occur with the typically low concentrations observed, a second precision summary was calculated using only concentrations which were at least $5 \mu\text{g}/\text{m}^3$. These results are also reported in Table 3-5. Note that these precision confidence interval results are significantly improved for the PM_{10} ; TSP sampling results were frequently at least $5 \mu\text{g}/\text{m}^3$, so the more restrictive summary did not change the TSP values as dramatically as the PM_{10} results.

3.3 Summary of Results from 1989 Through 1991

The particulate matter air monitoring results from 1991 continue to reflect concentration levels that are well below applicable ambient air quality standards. The results have not changed significantly since the beginning of the sampling program.

Table 3-6 is a summary of results reported since the beginning of the program through this year. The PM_{10} sampling at the NTS-60 site, and the TSP

sampling at NTS-60 and 40-Mile Wash sites, were included in this analysis. These data were chosen for this analysis because they have more continuity than those from the other samplers. The table shows that most of the maximum 24-hour values are well below the $150 \mu\text{g}/\text{m}^3$ level associated with the 24-hour standard, and the annual averages are well below the $50 \mu\text{g}/\text{m}^3$ annual average standard.

Table 3-6 also shows that the results during April through June and July through September are typically higher than those during January through March and October through December. The averages during the higher and lower periods can be a factor of two to three different. Part of the explanation for higher averages is the occurrence of the higher individual values, as seen by the 24-hour maxima shown in the table.

It is important to keep in mind that the low concentrations typically observed in the network often approach the threshold of reliable measurement using the high-volume air sampling technique. This is particularly important when examining long-term averages, that can be a combination of mostly low values combined with a few higher results. The "t-test" statistical analysis was applied to the monthly averages of the annual periods by sampler, and to the TSP results from the two sites. These comparisons showed there to be no statistically significant differences between the data sets compared. This conclusion did not change when outlier higher concentrations were removed from the 1990 data.

Table 3-1. First Quarter 1991

Results are shown in micrograms per standard cubic meter

SAMPLE DATEPM-10 RESULTS....			TSP RESULTS.....		
	MS-1	MS-2	FM-3		MS-5	MS-6	FM-4
01/06/91	1	0	0		4	4	3
01/12/91	1	3	4		6	(2)	11
01/18/91	2	2	1		(1)	(1)	(1)
01/24/91	5	5	4		(1)	(1)	(1)
01/30/91	6	6	3		27	27	24
02/05/91	5	5	5		14	(1)	(1)
02/11/91	11	9	6		(1)	(1)	11
02/17/91	4	4	5		10	9	14
02/23/91	7	7	5		13	10	14
03/01/91	1	1	2		4	4	4
03/07/91	2	2	3		4	4	5
03/13/91	6	6	5		14	13	14
03/19/91	4	5	5		14	14	16
03/25/91	9	9	10		21	20	23
03/31/91	7	7	(2)		13	12	12
Reported	100.0%	100.0%	93.3%		80.0%	66.7%	80.0%
Average	5	5	4		12	12	13
Highest	11	9	10		27	27	24
2nd-High	9	9	6		21	20	23

Sampler Identifications and Footnotes:

MS-1: Primary PM-10 Sampler at NTS-60 (Main) Site
 MS-2: Collocated PM-10 Sampler at NTS-60 (Main) Site
 FM-3: PM-10 Sampler at 40-Mile Wash Site

MS-5: Primary TSP Sampler at NTS-60 (Main) Site
 MS-6: Collocated TSP Sampler at NTS-60 (Main) Site
 FM-4: TSP Sampler at 40-Mile Wash Site

- (1) Sample void: motor brush damage affected filter
 (2) Sample void: torn filter

Table 3-2. Second Quarter 1991
Particulate Matter Air Quality Data

Results are shown in micrograms per standard cubic meter

SAMPLE DATEPM-10 RESULTS...		TSP RESULTS.....		
	MS-1	MS-2	FM-3	MS-5	MS-6	FM-4
04/06/91	22	22	16	(2)	49	41
04/12/91	6	5	4	12	11	13
04/18/91	6	5	(1)	10	9	(1)
04/24/91	18	19	18	33	33	33
04/30/91	10	10	10	20	19	19
05/06/91	9	9	9	18	16	14
05/12/91	10	10	11	22	21	20
05/18/91	8	9	(4)	21	21	21
05/24/91	11	11	11	18	18	17
05/30/91	22	21	34	63	(5)	103
	(3)					
06/05/91	20	17	22	37	37	41
06/11/91	21	21	(1)	40	41	(1)
06/17/91	12	11	(1)	28	23	(1)
06/23/91	15	15	(1)	27	24	(1)
06/29/91	11	11	11	(6)	(4)	26
Reported	100.0%	100.0%	66.7%	86.7%	86.7%	73.3%
Average	13	13	15	27	25	32
Highest	22	22	34	63	49	103
2nd-High	22	21	22	40	41	41

Sampler Identifications and Footnotes:

MS-1: Primary PM-10 Sampler at NTS-60 (Main) Site
MS-2: Collocated PM-10 Sampler at NTS-60 (Main) Site
FM-3: PM-10 Sampler at 40-Mile Wash Site

MS-5: Primary TSP Sampler at NTS-60 (Main) Site
MS-6: Collocated TSP Sampler at NTS-60 (Main) Site
FM-4: TSP Sampler at 40-Mile Wash Site

- (1) Sample void: electrical power outage
- (2) Sample void: motor problem
- (3) MS-1 void on 5/12: torn filter; collocated result reported
- (4) Sample void: operator error
- (5) Sample void: check weight out of tolerance
- (6) Sample void: timer failure

Table 3-3. Third Quarter 1991
Particulate Matter Air Quality Data

Results are shown in micrograms per standard cubic meter

SAMPLE DATEPM-10 RESULTS...		TSP RESULTS.....		
	MS-1	MS-2	FM-3	MS-5	MS-6	FM-4
07/05/91	25	27	27	62	59	55
07/11/91	13	13	12	(2)	(2)	24
07/17/91	10	10	9	15	19	18
07/23/91	9	9	9	17	18	17
07/29/91	14	14	15	35	38	39
	(1)					
08/04/91	10	12	32	20	(3)	54
08/12/91	33	31	46	61	63	88
08/18/91	15	15	15	24	26	24
08/24/91	15	16	10	(3)	29	21
08/30/91	11	14	11	28	26	28
09/03/91	17	17	17	45	45	46
09/09/91	14	15	18	33	31	43
09/15/91	6	6	6	15	20	17
09/21/91	18	18	18	35	49	35
09/27/91	12	10	6	22	29	18
Reported	100.0%	100.0%	100.0%	86.7%	86.7%	100.0%
Average	15	15	17	32	35	35
Highest	33	31	46	62	63	88
2nd-High	25	27	32	61	59	55

Sampler Identifications and Footnotes:

MS-1: Primary PM-10 Sampler at NTS-60 (Main) Site
MS-2: Collocated PM-10 Sampler at NTS-60 (Main) Site
FM-3: PM-10 Sampler at 40-Mile Wash Site

MS-5: Primary TSP Sampler at NTS-60 (Main) Site
MS-6: Collocated TSP Sampler at NTS-60 (Main) Site
FM-4: TSP Sampler at 40-Mile Wash Site

- (1) MS-1 void on 7/11: motor problem; collocated result reported
(2) Sample void: motor problem
(3) Sample void: timer failure

Table 3-4. Fourth Quarter 1991
Particulate Matter Air Quality Data

Results are shown in micrograms per standard cubic meter

SAMPLE DATEPM-10 RESULTS....		TSP RESULTS.....		
	MS-1	MS-2	FM-3	MS-5	MS-6	FM-4
10/03/91	8	8	8	19	23	19
10/09/91	11	10	7	20	22	16
10/15/91	8	8	5	16	16	12
10/21/91	9	9	8	23	22	17
10/27/91	4	3	9	(1)	18	55
11/02/91	4	4	4	(1)	8	11
11/08/91	9	9	(1)	(1)	18	9
11/14/91	6	6	13	16	15	40
11/20/91	4	4	3	14	12	10
11/26/91	12	13	11	25	26	24
12/02/91	10	11	8	38	34	41
12/08/91	5	6	5	10	9	8
12/14/91	6	5	4	12	10	9
12/20/91	2	2	6	4	4	26
12/26/91	3	4	5	(1)	9	12
Reported	100.0%	100.0%	93.3%	73.3%	100.0%	100.0%
Average	7	7	7	18	16	21
Highest	12	13	13	38	34	55
2nd-High	11	11	11	25	26	41

Sampler Identifications and Footnotes:

MS-1: Primary PM-10 Sampler at NTS-60 (Main) Site
MS-2: Collocated PM-10 Sampler at NTS-60 (Main) Site
FM-3: PM-10 Sampler at 40-Mile Wash Site

MS-5: Primary TSP Sampler at NTS-60 (Main) Site
MS-6: Collocated TSP Sampler at NTS-60 (Main) Site
FM-4: TSP Sampler at 40-Mile Wash Site

(1) Sample void: motor problem

Table 3-5. Summary of 1991 Precision Assessment Results

Reporting Period	<u>PM₁₀</u>		<u>TSP</u>	
	UL	LL	UL	LL
Jan - Mar	+89.5%	-76.5%	+17.1%	- 5.7%
Apr - Jun	+16.5%	- 9.0%	+15.1%	- 3.5%
Jul - Sep	+11.2%	-16.7%	+10.3%	-30.2%
Oct-Dec	+18.2%	-19.2%	+18.4%	-12.3%

Calculations made using only concentrations at or above 5 $\mu\text{g}/\text{m}^3$:

Jan - Mar	+12.3%	- 7.3%	+20.4%	- 4.2%
Apr - Jun	+16.5%	- 9.0%	+15.1%	- 3.5%
Jul - Sep	+11.2%	-16.7%	+10.3%	-30.2%
Oct - Dec	+13.1%	-14.7%	+19.4%	-12.7%

TABLE 3-6. Selected Results of Particulate Matter Sampling from 1989 Through 1991 in the Yucca Mountain Network

	PM-10: NTS-60		TSP: NTS-60		TSP: 40-Mile Wash	
	24-hr		24-hr		24-hr	
Period	Maximum Average		Maximum Average		Maximum Average	
<hr/>						
1989						
Jan - Mar	Samplers were not operating until 4/22/89					
Apr - Jun	18	12.5	39	23.3	65	32.4
Jul - Sep	42	18.1	90	36.7	94	37.9
Oct - Dec	17	6.1	89	16.9	23	11.5
Annual	42	12.2	90	25.6	94	27.3
1990						
Jan - Mar	33	5.4	12	7.1	25	10.0
Apr - Jun	30	12.5	66	28.3	106	32.5
Jul - Sep	41	15.9	80	32.8	82	33.4
Oct - Dec	62	12.0	150	29.2	26	13.2
Annual	62	11.4	150	24.3	106	22.3
1991						
Jan - Mar	11	4.9	27	12.1	24	12.7
Apr - Jun	22	13.4	63	26.7	103	31.7
Jul - Sep	33	14.8	62	31.8	88	35.1
Oct - Dec	12	6.7	38	17.9	55	20.6
Annual	33	9.9	63	22.2	103	25.0

Notes: There is not a statistically significant difference between the three annual averages by sampler.

The table shows maximum 24-hour sampling results, and averages by quarterly and annual periods, shown in micrograms per cubic meter.

PM-10 is the inhalable portion of particulate matter.
TSP is total suspended particulate matter.

Sampling is performed using high-volume air samplers.